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GB 2345235 A **JP 2002012541 A**

(58) Field of Search
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Other: **On-line: WPI, EPODOC, JAPIO**

(54) Abstract Title
Automated planter

(57) An automated planter for transplanting seedlings is described, the planter comprising: a planting device: plant extraction means (5 figure 2), having a plurality of members (6, figure 2) adapted to remove a row of plants (1 figure 2) from a propagation tray (2 figure 2)and deposit them on a plant transport means 13; propagation tray locating means, arranged to position each propagation tray (2) relative to the plant extraction means 5; and plant transport means having a static state, in which the transport means presents a plurality of holding ports, 17 to receive the row of plants, and a moving state, in which the holding ports transport the plants to the planting device.

Preferably, the planter lifts the plants out of their cells in the tray by inserting fingers, which are caused to converge to pinch the root ball. Preferably, the transport means comprises two tracks, such that one can be loaded while the other is transporting plants to the planting device.

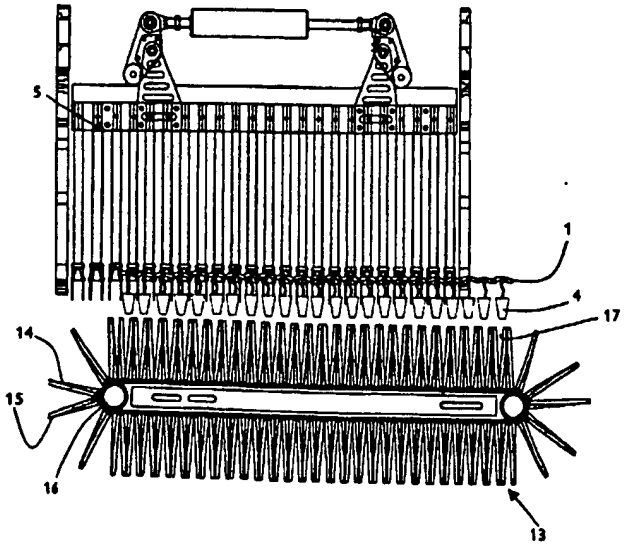

Fig. 4

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The claims were filed later than the filing date but within the period prescribed by Rule 25(1) of the Patents Rules 1995.

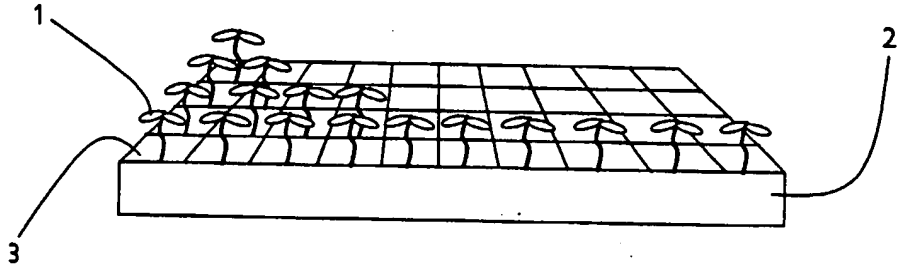

Fig. 1

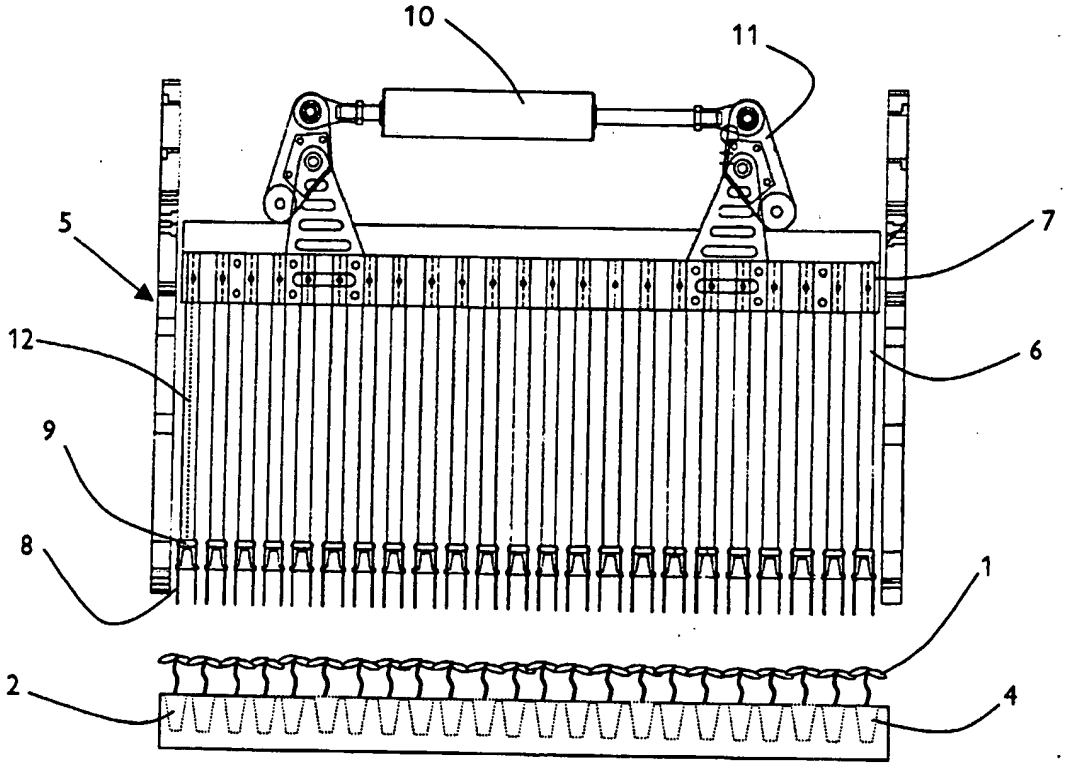

Fig. 2

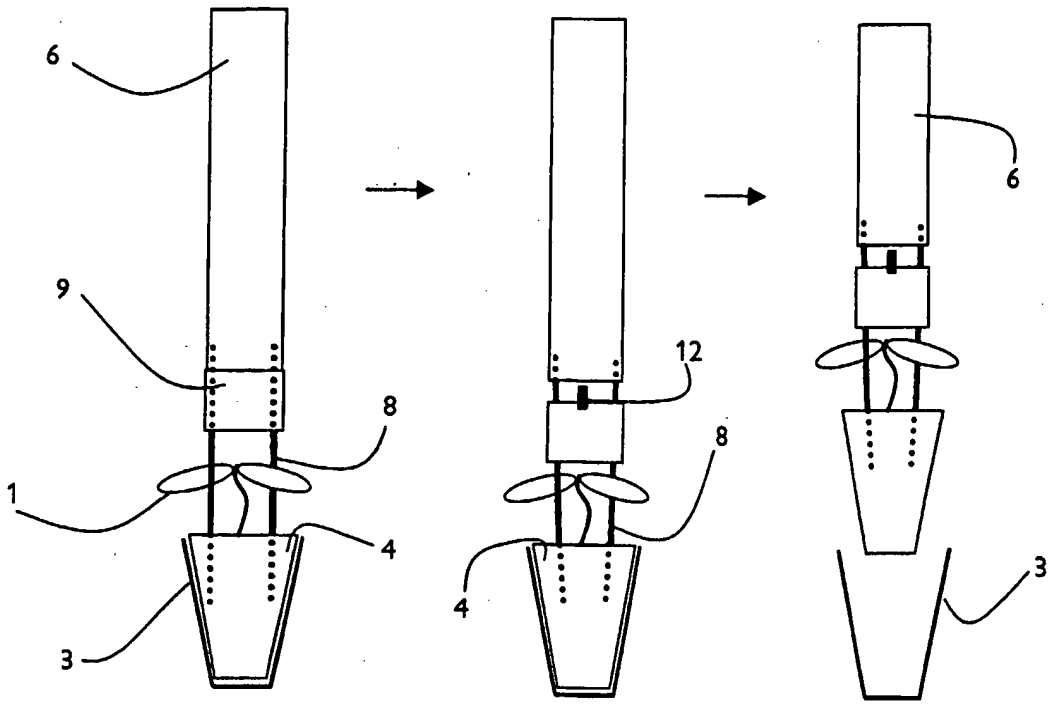

Fig.3

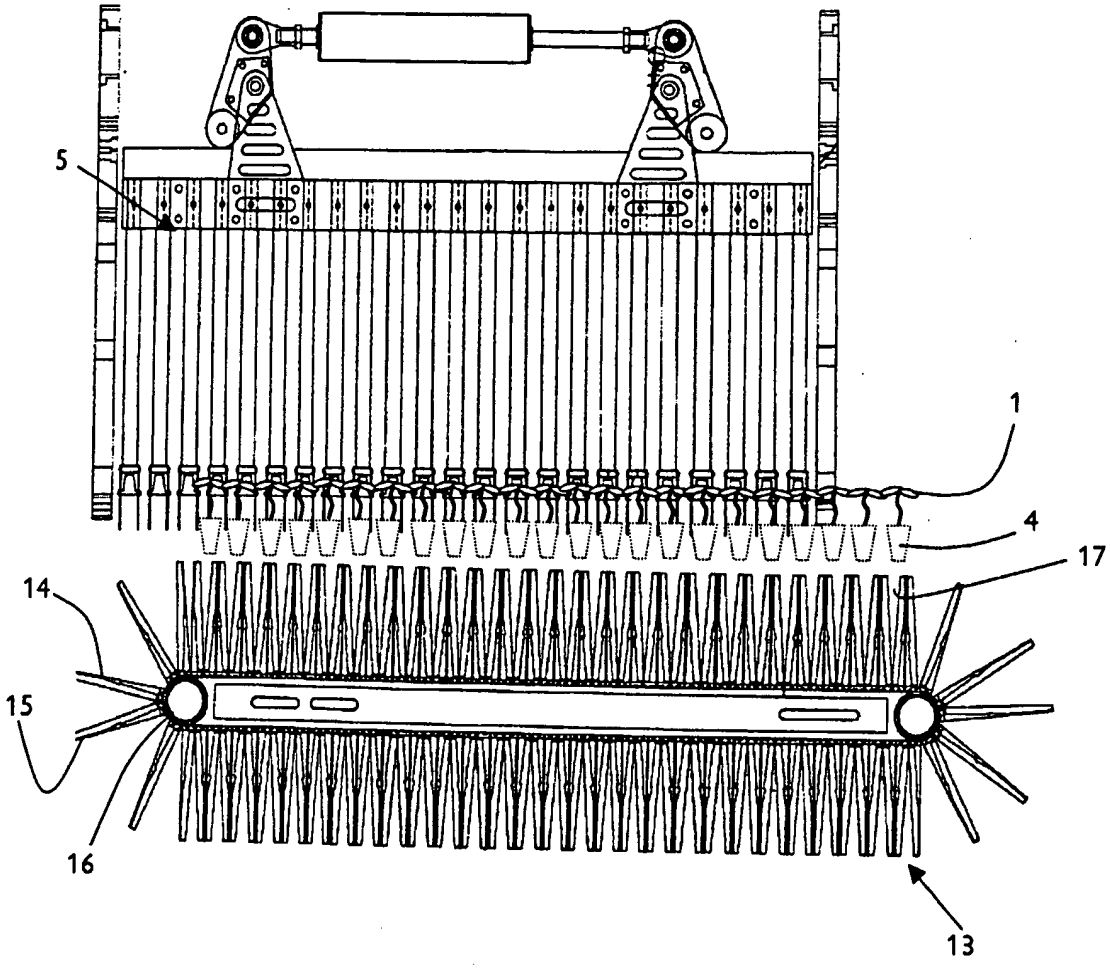

Fig. 4

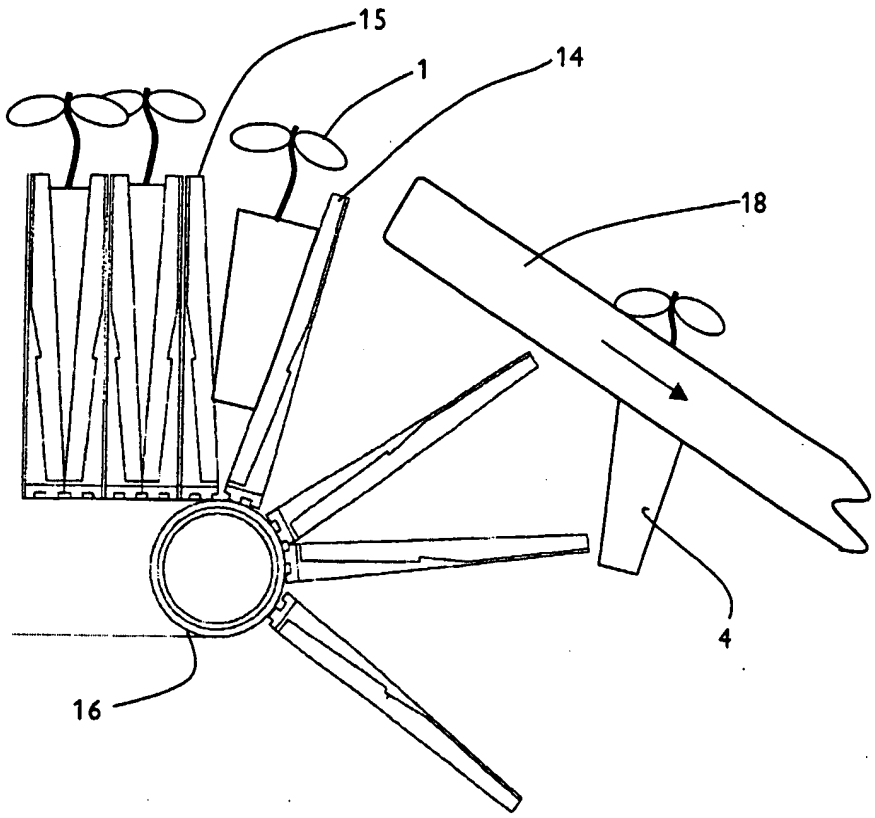

Fig. 5

AUTOMATED PLANTER

Field of the Invention

This invention relates to the field of automated planting, and more specifically to the planting of plants from a propagation tray.

Background of the Invention

Agricultural farming is a vital component of the food supply system in any country. In the past, such farming was extremely labour intensive. However, over the years technology has been applied to automate various tasks and thus improve the efficiency of the farming as a whole.

One area where machines have been particularly useful is in repetitive functions such as planting. In order for an individual plant (or crop) to enjoy optimum growing conditions, certain conditions must be met; one such condition is inter-plant spacing. Machines can be designed to provide constant spacing.

Although automation of many farming functions has taken place, there are still aspects where a human interaction is preferable (e.g. where the plant may be damaged). In a semi-automated system, the most likely point of a 'bottle neck' is with the human component.

Other disadvantages of involving humans include labour charges and limited work hours. With a machine, a minimal human workforce can successfully carry out the same work of much larger all-human workforce.

Certain plant, such as lettuces, leeks and the Brassica plant (examples of which are cabbages and cauliflowers), are grown in propagation trays until they are a reasonable size. Once the plants are of a suitable size, they can be transferred into a field so that they grow to maturity. Each propagation tray comprises a grid of cells, with each cell housing an individual plant.

At present, in order to transfer such plants to a field each plant must be removed from the tray, by hand, and fed into the planting machine. The need for human input means that this planting system suffers from the aforementioned problems. There is a need for a machine that is capable of carrying out the human elements of the planting process without damaging the crops being planted.

Summary of the Invention

Accordingly, the invention provides an automated planter assembly comprising: a planting device; plant extraction means having a plurality of members, which remove a row of plants from a propagation tray and deposit them on a plant transport means; propagation tray locating means, which position each propagation tray relative to the plant extraction means; and plant transport means having a static state, wherein the transport means presents a plurality of holding ports to receive the row of plants, and a moving state, wherein the holding ports transport the plants to the planting device.

It will be understood by the skilled man that propagation trays consist of a plurality of planting cells arranged in a grid formation.

Preferably, the spacing between each plant extraction member is such that extraction means correctly aligns with a row on a standard propagation tray.

Preferably, each plant extraction member may comprise at least two fingers, mounted on a main body, and an actuator means, which causes the fingers to converge, wherein, in use, the fingers engage an individual plant in the propagation tray.

It will be understood that the converging fingers will pinch the soil and root portion of the plant and hold it gently, yet firmly, thus permitting its removal from the propagation tray.

Advantageously, the actuator may be slidably mounted on the fingers such that the movement of the actuator in one direction causes the fingers to converge, whereas movement in the opposition direction causes the fingers to align substantially parallel to one another.

Preferably, the number of members on the plant extraction means may correspond to the number of cells in a row presented by the propagation trays located in the propagation tray receiving means.

Advantageously, the actuator means may all be controlled by a common control means so that the row of individual plants may be engaged simultaneously.

Preferably, the propagation tray locating means comprises a sensor to determine the number of rows of plants held, wherein this data is fed back to an operating

system. Further preferably, the propagation tray may have markings thereon, which alert the system to its dimensions.

The plant extraction means may move relative to the propagation tray locating means so that once the plants have been removed from a row the extraction means moves on to the next row. Alternatively, the propagation tray locating means may move the tray so that a full row of plants is always presented to the extraction means.

The plant transport means may comprise a continuous track of holding ports, which receive the soil and root portion of the plants, and a control means, which determines whether the track is moving or static.

Preferably, the continuous track comprises a plurality of fin pairings, wherein each fin pairing comes together to form a holding port.

Advantageously, the plant transport means may comprise two continuous tracks of holding ports, so that when the first track is static the second track may be moving. In this way, one track can be filled with a row of plants from the extraction means whilst the second track is transporting a row of plants to the planning device, thus reducing the down time of the system.

The nature of this assembly is such that a computer system is required to coordinate at the associated movements of the planter assembly.

Brief Description of the Drawings

In the drawings, which illustrate a preferred embodiment of the invention:

Figure 1 is a diagrammatic representation of a propagation tray;

Figure 2 shows the alignment between a propagation tray and the extraction means;

Figure 3 shows the process by which an individual plant is removed from a cell of the propagation tray;

Figure 4 shows the alignment between the extraction means and the transport means which permits a row of plants to be transferred; and

Figure 5 shows how each individual plant is taken from the end of the transport means by the planter device.

Detailed Description of the Preferred Embodiment of the Invention

It is standard practice to grow plants 1 from seed in propagation trays 2. Such practice allows the farmer to easily control the plant's environment until it has grown to a suitable age. Propagation trays come in a range of sizes, and can have a range of cells 3 therein. The type of propagation tray used can depend on the type of plant being grown. In Figure 1, a typical propagation tray 2 is illustrated; the tray is partially stocked with plants 1, each plant having its own individual cell 3.

The main function of the invention is to carry out the task of extracting plants, from such propagation trays, and presenting them to an automated planting device (of a type commonly known in the art). At present, extraction of plants from propagation trays is carried out by hand and this imparts limitations on the whole system.

There are two main functions which must be automated, they are: extraction of the plants from their propagation trays; and transport of the plants to the automated planting device.

Figures 2 & 3 illustrate the components used, in the preferred embodiment, to replace the extraction function.

In Figure 2, the alignment of the propagation tray 2, and thus the plants 1, relative to the extraction means 5 can be appreciated. The alignment of the tray 2 with the extraction means is controlled by the propagation tray locating means (not shown). In the preferred embodiment, the locating means comprise: a housing that holds the propagation tray(s), which are being worked on by the extraction device; a waiting area where the next propagation tray(s) are stored; and a transport mechanism, which replaces the emptied propagation trays with fresh propagation trays. A piston arrangement is used in the preferred embodiment, but alternative mechanisms will be appreciated by the skilled man.

In the preferred embodiment, the extraction means 5 has twenty-three extraction members 6, this number corresponds the number of cell in row on a standard propagation tray 2. It is appreciated that alternative numbers of extraction members may also be used effectively.

Each extraction member 6 has four fingers 8 and an actuating means 9, located at one end thereof. The alignment of the tray 2 and the extraction means 5 is such that each extraction member 6 is aligned with an individual cell 3 of the tray 2. At the opposite end of the extraction member 6 to the fingers 8 the member is connected to a control bar 7; all of the separate extraction members are connected to the control bar 7.

The control bar is driven by a single piston 10 and a self-balancing rotor mechanism 11. This arrangement ensures that equal pressure is enforced by each extraction member 6, thus preventing the system from locking up. Each extraction member 6 has a remote control device 12 that passes the drive of the piston 10 on to the actuator 9, located on each extraction member 6.

The interaction between each individual extraction member 6 and an individual plant 1 can be better appreciated from Figure 3, which shows a three stage process whereby the plant is removed from its cell in the propagation tray.

Once the plant is aligned with the extraction member, the member moves towards the plant thus causing the fingers 8 to be inserted into the base of the plant 4(comprising soil and roots). The depth the fingers 8 pass in the base 4 is determined by the type of propagation tray being used. Once the fingers 8 have reached the desired depth, the actuator 9 is activated by remote control means 12.

The shape of the actuator is such that as it is forced down the fingers 8 it causes them to converge. The convergence of the fingers 8 imparts a pinching action on the plant base 4 and holds it firmly.

Once the plant is held firmly, the extracting member 6 lifts it out of its cell 3 in the propagation tray. In order to retain the plant, the actuator 9 is maintained in the active position. To detach the plant from the extraction member 6 the actuator returns to its original position, thus allowing the fingers 8 to return to their original, substantially parallel, alignment.

It is appreciated that the number of fingers and their spacing may vary depending on the dimensions of the cell size of the propagation tray being worked. The only limitation on the number of fingers is that there must be at least two, so as permit the pinching mechanism.

Once the row of plants has been extracted from the propagation tray it moves on the second function that is automated by the invention, namely the transport and presentation of the individual plants to the planting device. Figures 4 & 5 show the components involved in automating this function in the preferred embodiment.

The alignment of the extraction means 5, laden with a row of extracted plants 1, and the plant transport means 13 can be appreciated from Figure 4.

In the preferred embodiment, the plant transport means 13 comprises two continuous tracks 16 on which is mounted a plurality of fins. There are two types of fin, and they are arranged alternately around the body of the track. Fins 14 & 15 are arranged so that when they come together they form a holding port 17. The holding port 17 is shaped so to receive the plant base 4 of an individual plant 1. The alignment of the extracting means 5 and the transport means 13 is such that each plant 1 locates within a holding port 17. It is appreciated that the number of holding ports on a track should be at least double the number of extraction members on the extraction means.

The tracks 16 are arranged side by side and are driven by a common drive means. When the system is in operation, only one track is ever moving. In this way, one track can be loaded with plants while the other is transporting its load to the planting device. A clutch arrangement (not shown) allows the movement of the two tracks 16 to be alternated appropriately.

When transferring the plants from the extraction means to the holding ports of the transport means, the retraction of the actuator should be enough to release the plants. It is appreciated that an additional ejection device may be incorporated to ensure release of the plants into the holding ports 17. A suitable ejection device may involve a pin driven by the control bar.

Once the row of plants has been deposited on the transport means (sensor means may be involved to monitor state of plant deposition), the loaded track 16 carries the plants to the planting device.

Figure 5 shows how each individual plant 1 is passed on the automated planting device. At the end of the plant transport means is located a planter delivery belt 18. The delivery belt 18 comprises two contra rotating belts of soft rubber that travel at the

same speed. It is important that the belts travel at the same speed so that the plants, which are held by their stalks, foliage, leaves or leaf area, are not rotated and damaged as they travel along the belt to the planting device.

The positioning of the delivery belt 18 is such that, as the fins 14 & 15 are turning the corner of the track 16 and are moving apart, the stalk, foliage, leaves or leaf area of each plant 1 is presented to the delivery belt 18. The delivery belt 18 picks up the plants and transports them to be planted.

The rate at which each plant is presented to the delivery belt can determine how far apart they are planted in the ground. It is appreciated that other factors can be varied to control the distancing of the plants.

The man skilled in the art will appreciate that it is necessary to include sensors through out the system, to ensure that the functions run smoothly. Suitable sensors include lasers, photo-electric and ultrasonic types.

In order to coordinate the various components of the system a central computer is used, which collects information from the various sensors located around the system.

Claims

1. An automated planter assembly comprising: a planting device; plant extraction means having a plurality of members, adapted to remove a row of plants from a propagation tray and deposit them on a plant transport means; propagation tray locating means, arranged to position each propagation tray relative to the plant extraction means; and plant transport means having a static state, in which the transport means presents a plurality of holding ports to receive the row of plants, and a moving state, in which the holding ports transport the plants to the planting device.

2. An assembly in accordance with claim 1, wherein each plant extraction member comprises at least two fingers, mounted on a main body, and an actuator means, operable to cause the fingers to converge, wherein, in use, the fingers engage an individual plant in the propagation tray.

3. An assembly in accordance with claim 2, wherein the actuator means is slidably mounted on the fingers such that the movement of the actuator means in one direction causes the fingers to converge, and movement in the opposition direction causes the fingers to align substantially parallel to one another.

4. An assembly in accordance with claim 2 or claim 3, wherein the actuator means are all controlled by a common control means so that a row of individual plants may be engaged simultaneously.

5. An assembly in accordance with any preceding claim, wherein the propagation tray locating means comprises sensor means to determine the number of rows of plants in a propagation tray, the data from the sensor means being fed to an operating system.

6. An assembly in accordance with any preceding claim, wherein the plant extraction means is arranged to move relative to the propagation tray locating means so that

once plants have been removed from a row the extraction means may move on to the next row.

7. An assembly in accordance with any one of claims 1 to 5, wherein the propagation tray locating means is arranged to move a tray so that a full row of plants is always presented to the extraction means.

8. An assembly in accordance with any preceding claim, wherein the plant transport means comprises a continuous track of holding ports, which receive the soil and root portion of the plants, and a control means, which determines whether the track is moving or static.

9. An assembly in accordance with claim 8, wherein the continuous track comprises a plurality of fin pairings, wherein each fin pairing comes together to form a holding port.

10. An assembly in accordance with claim 8 or claim 9, wherein the plant transport means comprises two continuous tracks of holding ports, and control means operable such that when one track is static the other track may be moving.

11. An assembly in accordance with claim 10, wherein the extraction means is operable to fill one track with a row of plants whilst the other track is transporting a second row of plants to the planting device.

12. An assembly in accordance with any preceding claim, further a computer system arranged to coordinate at the associated movements of the planter assembly.

13. An assembly in accordance with any preceding claim, wherein the locating means comprises: a housing that holds the propagation tray(s), which are being worked on by the extraction device; a waiting area where the next propagation tray(s) are stored; and a transport mechanism, which replaces the emptied propagation trays with fresh propagation trays.

14. An assembly in accordance with any preceding claim, wherein each extraction member comprises four fingers and an actuating means, located at one end thereof.

15. An assembly in accordance with claim 14, wherein an end of each extraction member opposite to the fingers is connected to a common control bar.

16. An assembly in accordance with any preceding claim, wherein the extraction means is arranged to lift each plant out of its respective cell in a propagation tray.

17. An assembly in accordance with any preceding claim, further comprising an ejection device arranged to ensure release of the plants from the extraction means into the holding ports.

18. An assembly in accordance with claim 17, wherein the ejection device comprises a pin.

19. An assembly in accordance with any preceding claim, wherein the planting device comprises a planter delivery belt.

20. An assembly in accordance with claim 19, wherein the delivery belt comprises two contra rotating belts of soft rubber arranged to travel at the same speed.

21. An assembly in accordance with claim 19 or claim 20, further comprising means for varying the rate at which each plant is presented to the delivery belt to determine how far apart they are planted in the ground.

22. An assembly substantially as hereinbefore described with reference to and/or as shown in the accompanying drawings.

23. An assembly in accordance with any preceding claim, in combination with a propagation tray comprising a plurality of planting cells arranged in a grid formation, the spacing between each plant extraction member being arranged such that the extraction means correctly aligns with a row of cells on the tray.

24. A combination in accordance with claim 23, wherein the number of members on the plant extraction means corresponds to the number of cells in a row of the tray.

25. A combination in accordance with claim 23 or claim 24, wherein the propagation tray comprises markings arranged to alert a control system of the assembly to the tray's dimensions.

26. A method of extracting and planting plants from a propagation tray, the method comprising the steps of:

positioning the propagation tray relative to a plant extraction means with propagation tray locating means;

removing a row of plants from the tray using the plant extraction means;

depositing the row of extracted plants on a plant transport means, the transport means having a plurality of holding ports to receive the row of plants;

operating the plant transport means to transport the deposited plants to a planting device; and

operating the planting device to deliver the plants to the ground.

27. A method in accordance with claim 26, wherein the step of removing the plants comprises removing the row of plants substantially simultaneously from the tray.

28. A method in accordance with claim 26 or claim 27, wherein the step of extracting the plants comprises: inserting a respective at least two fingers into the soil and root portion of each plant; causing the fingers to converge; and lifting the plant out of its cell.

29. A method in accordance with claim 28, wherein the step of causing the fingers to converge comprises pinching the soil and root portion of the plant.

30. A method in accordance with claim 29, wherein the step of depositing the row of extracted plants comprises returning the fingers to a substantially parallel alignment.

31. A method in accordance with any one of claims 26 to 30, wherein the transport means comprises at least two tracks, the method further comprising the steps of depositing an extracted row of plants in the holding ports of a first, stationary one of said tracks, and simultaneously operating a second one of said tracks, in which another row of plants had previously been deposited, to transport said another row to the planting device.

32. A method of extracting and planting plants from a propagation tray, the method being substantially as hereinbefore described with reference to and/or as shown in the accompanying drawings.

33. An automated planter assembly in combination with a propagation tray, substantially as hereinbefore described with reference to and/or as shown in the accompanying drawings.

Application No:	GB 0209672.5	**Examiner:**	Rhys Williams
Claims searched:	1-33	**Date of search:**	12 August 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
A	-	GB 2345235 A	(OPICO) Whole document relevant.
A	-	JP 2002-125414	(KUBOTA) Note plant extraction means in figure 12.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[V]:

A1D A1E

Worldwide search of patent documents classified in the following areas of the IPC[7]:

A01C

The following online and other databases have been used in the preparation of this search report:

WPI, EPODOC, JAPIO